Space Weather Technical Forecast

Issued on Thursday, 06 July 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence declining. Chance of R1/R2 radio blackouts. G1/Minor Storm to G2/Moderate Storm possible late 06 July or early 07 July with CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with only one M-class flare, an M1.0 at 05/1858UTC possibly from AR3361, but with a contribution from AR3354 beyond the northwest limb. There are eight sunspot regions on the visible disc. AR3361 has evolved notably through the last 24 hours, increasing in both length and complexity. AR3359 has also evolved into an increasingly complex region. ex-AR3354 remains as an active region despite the farsided location. AR3363 also appears to be a large and active region as it rotates across the southeast limb, but due to the location, a full analysis is not yet possible. A CME appears to have emanated from the southeast quadrant around 06/0600UTC but no imagery is yet available to undertake a full analysis.

Solar Wind / Geomagnetic Activity: The solar wind as observed at L1, appears to be indicative of a weak CME or possible coronal hole high speed stream connection to weak coronal hole 20 close to the southwest limb. Solar wind speeds are around 450km/s on a rising trend from 350km/s. Density is around or slightly above average. Total magnetic field strength has increased from weak to moderate levels, with a notable discontinuity from around 05/1341UTC. This aligns with similar discontinuities in both speed and density, which could represent the onset of the high speed stream of arrival of the weak CME. The north-south component, Bz, has varied weakly through much of the period, but with a moderate variation through the last 6 hours, with a negative peak of -9nT at 06/0929UTC. The phi angle was mainly positive (towards the Sun) throughout. Geomagnetic activity has been Quiet to Unsettled.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background levels. High energy electron flux (greater than 2MeV), as observed by GOES16, started at high levels, with a peak of 3580pfu at 05/1650 UTC, but has been at moderate to background levels since 05/2125UTC. The 24-hour integrated fluence has been on a slightly declining trend and has recently fallen below the Active (1e8 integrated pfu) threshold. A fluence of 1.4e8 pfu was recorded at 06/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is forecast, with a chance of M-class flares, but a decreasing risk of X-class flares from a region which has rotated off the solar disc. A number of newly evolving regions could present an increasing risk of activity through the period.

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Solar Wind / Geomagnetic Activity: A partial halo CME from a filament eruption near AR3359 on 04 July is forecast to arrive at Earth either late on 06 July, or on 07 July, with a speed of around 550km/s. Otherwise solar wind speeds are forecast to increase to 500-600km/s due to a connection to coronal hole 22 on 07 July, although this connection could be masked by the CME arrival. Geomagnetic activity is forecast to increase from Quiet to Unsettled, to Active with a risk of G1/Minor or G2/Moderate storms either later on 06 July or on 07 July due to the possible CME arrival. This could be enhanced by the possible concurrent coronal hole high speed stream connection. Geomagnetic enhancements are then possible through the remainder of the period, but with a decreasing magnitude as speeds and magnetic effects wane.

Energetic Particles / Solar Radiation: The high energy (greater than 10MeV) proton flux has a slight but declining chance of reaching the S1/Minor Storm threshold through the period. The risk reduces as AR3354 continues to rotate away from the northwest limb on the far side. High energy electron flux (greater than 2MeV) is expected to remain muted due to the geomagnetic enhancements following the CME arrival through 06 and 07 July, with a steady increase in diurnal peaks possible through 08 and 09 July. Electron fluence is likely to decline at first, with a steady increase in response to the increasing electron flux.

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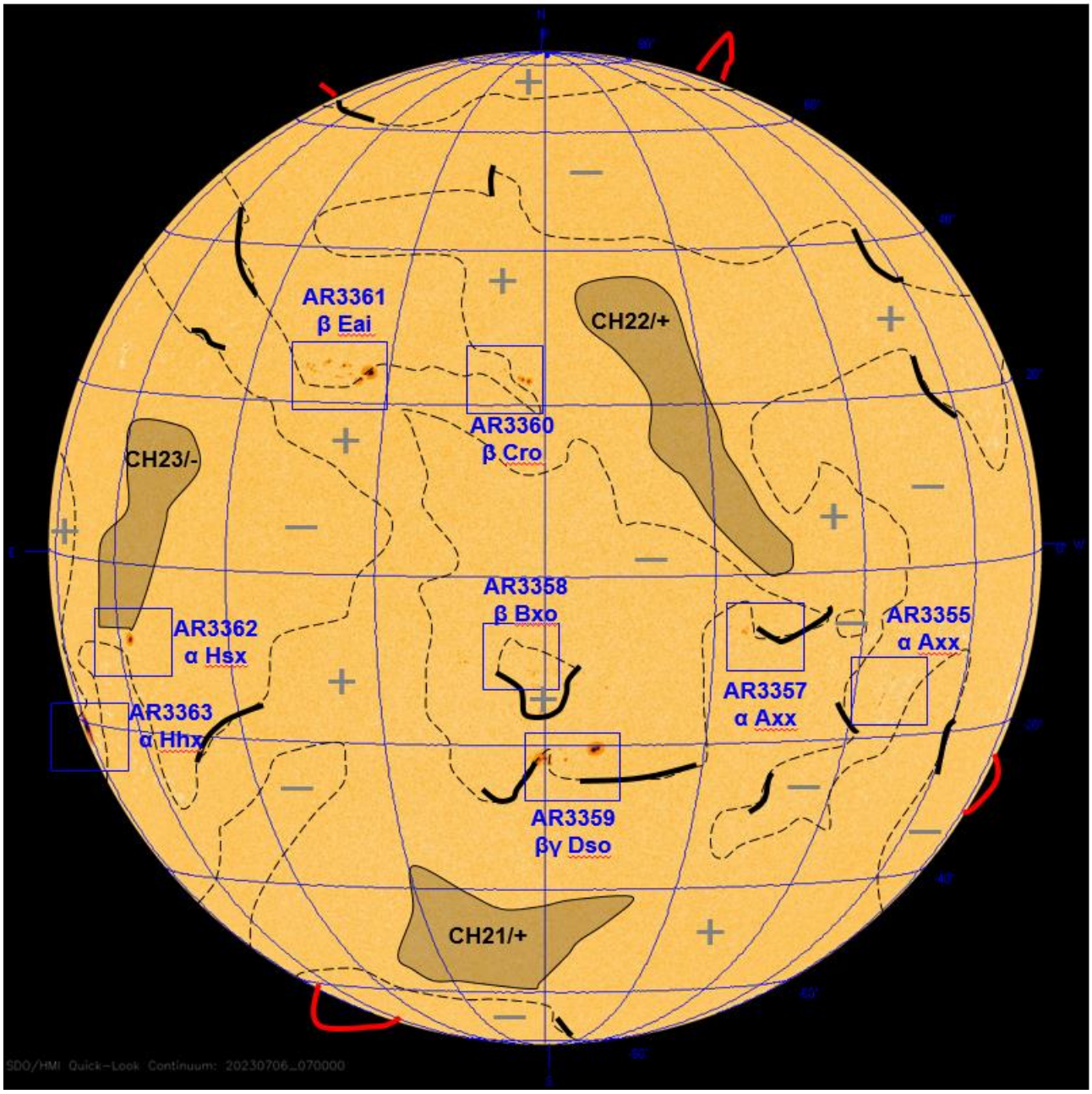
Figure 1. Solar Analysis Valid 06/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A partial halo CME which left the Sun on 04 July, is forecast to arrive at Earth either late on 06 July or early on 07 July, but with low confidence in the actual arrival time. There appears to be a feature currently affecting the solar wind, with uncertainty around whether this is an embedded transient CME or connection to weak coronal hole 20 which is close to the southwest limb with signatures of both possibilities within the L1 data.

Coronal hole 22 is then due to connect with the Earth on 07 July, with may occur concurrently with the CME arrival and therefore any CIR may be masked by the CME effects. Solar wind speeds are expected to be mainly around 400-500km/s. with slightly increased speeds due to any CME arrival.

Mainly Quiet to Unsettled at first, becoming Active with a risk of G1/Minor or G2/Moderate storms due to the CME arrival. The risk if highest om 07 July, with a decreasing risk through the period, taking into account the effects of any magnetic cloud following the CME.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	60	30	5
Strong	G3	No	5	10	5	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
04/1000	Partial halo	Filament eruption	SE quadrant	550km/s	06/0000UTC	G1 or G2 possible

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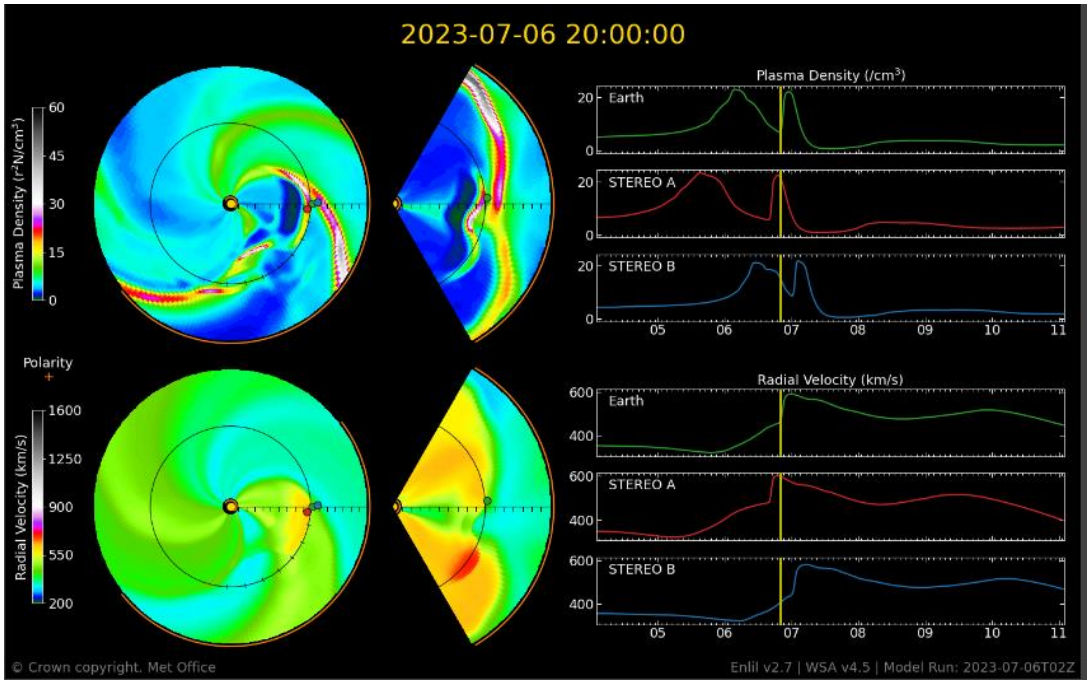
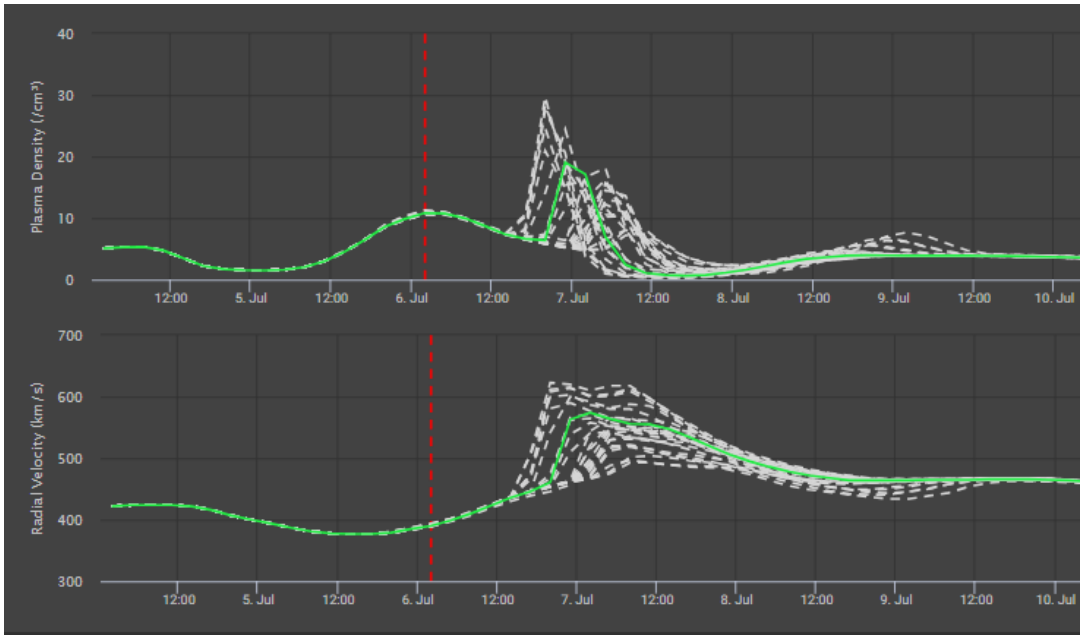
Figure 2: MOSWOC Enlil and MOSWOC Enlil ensemble showing the possible arrival time and range in forecast arrival times for the 04 July CME.





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Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate, with a recent M-class flare from AR3361 in the northeast quadrant. This region is continuing to evolve and provides the greatest risk of further significant flaring. ex-AR3354 just beyond the northwest limb continues to present a decreasing risk, with any flares increasingly likely to become occulted as it moves further onto the farside of the Sun. AR3363 in the southeast appears to be large, with bright flux associated with the region. AR3359 is also magnetically complex and is in the vicinity of two large filaments, so presents both a flare and CME risk. The remaining regions are all magnetically simple or stable.

Solar activity is forecast to be mainly Low to Moderate, with a decreasing risk of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	30	30	30
Very Active	R3 to R5 X Class	No	10	5	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at background levels. There is a slight and declining chance of S1/Minor storm levels being reached through this period. This is mainly due to AR3354, given its favourable location near the western limb and although it has now transited to the far side the risk of radiation storms remains until it has rotated further onto the farside of the disc. The remaining regions on the disk currently only pose a very slight chance of a radiation storm.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	10	5	5	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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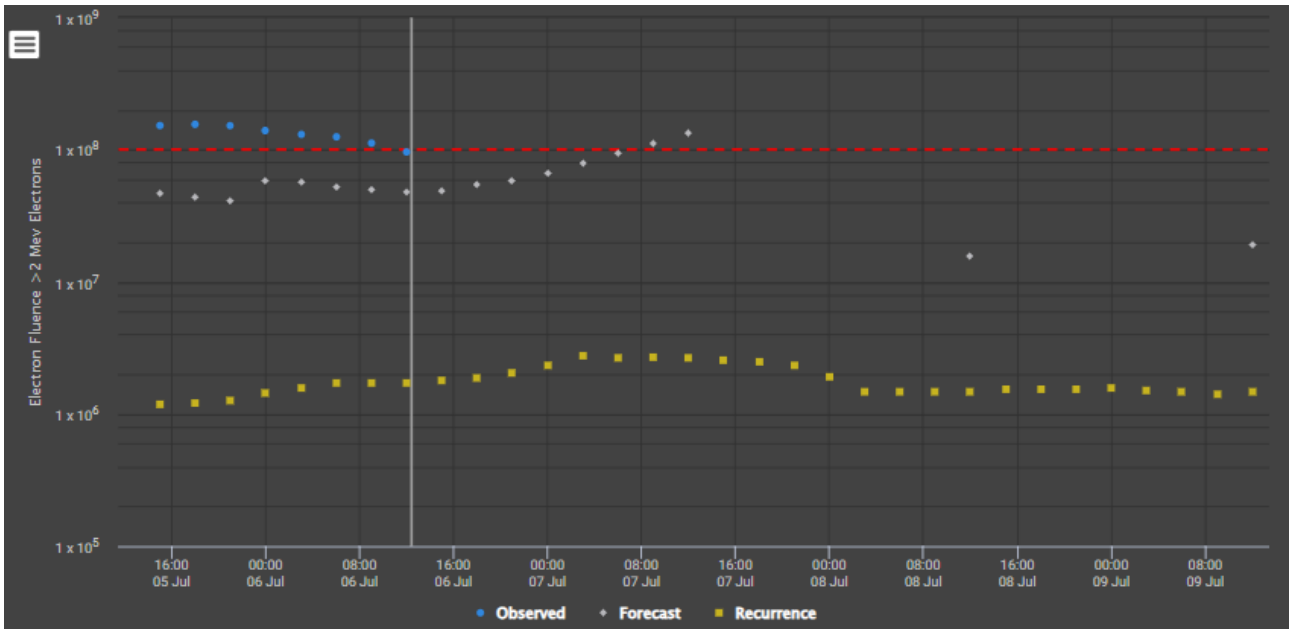
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) has fallen to background levels, previously being around moderate levels. This fall is likely due to the changes in the solar wind and possible weak transient effects. Significant geomagnetic enhancements are expected through the next few days which may continue to suppress electron flux levels, with a steady increase in diurnal peaks possible towards the end of the period.

Electron fluence is following a falling trend in line with the electron flux declining. This decline is expected to continue through 07 and perhaps 08 July, with a recovery possible towards the end of the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	30	20	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: MOSWOC electron fluence



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